THE ADJUST-a-FLUSH
A RETROFIT DEVICE TO REDUCE WATER CONSUMPTION IN TOILETS

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FOREWORD

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EXECUTIVE SUMMARY

The purpose of this project was to develop a convenient, affordable retrofit device for toilets that would conserve water while retaining the option of a a conventional flushing action. Although there are a number of water-saving retrofit devices for toilets on the market, none retains the conventional flushing mode. This lack of flexibility reduces consumer appeal. Because existing devices require some training, they can create difficulty for visitors and new users.

The need for such a water-conserving device is apparent. Conventional toilets waste significant amounts of water by using the same volume to remove both solid and liquid wastes. The average toilet uses about 22 litres for each flush. However, only 18 litres are actually required to remove solid waste, and 10 litres to remove liquid waste.

Interest in water conservation is growing among both consumers and municipalities across North America, due to rising water rates and environmental concerns. Several recent initiatives suggest that the potential market size for retrofit toilet devices is also increasing, in both Canada and the United States. In 1990, for example, the City of Edmonton hired a full-time employee to evaluate the feasibility of distributing water-reducing kits for shower heads and toilets. The City of Waterloo, Ontario, recently distributed 40,000 conservation kits to its water customers, including a water-saving device for toilets. In the United States, concerns over water shortage are also expected to create more demand for retrofit devices.

The work commenced with a study of the literature, patents and existing devices, and then undertook development of a prototype with the assistance of an industrial designer. After successful

laboratory tests, samples of the product, called ADJUST-a-FLUSH, were installed in four homes on a trial basis, over a two-month period. Participants were then interviewed. Federal and provincial authorities were contacted to determine the requirements for obtaining the necessary approvals to market the proposed retrofit device.

Two marketing studies were conducted. Sintra Group Inc. studied consumer response to the ADJUST-a-FLUSH concept. The Faculty of Business at the University of Alberta, prepared a marketing plan for ADJUST-a-FLUSH, which involved a survey of competition and a study of market potential in both Canada and the United States.

The University of Alberta study found the ADJUST-a-FLUSH design is unique, because it combines the features of existing flushing methods without the loss of the.conventional flushing action, and it could be manufactured in Alberta and sold at a retail price of about $10. And, according to the Sintra Group, there is a potential Alberta market of at least 234 000 units, providing that the device is properly marketed and promoted.

In conclusion, the ADJUST-a-FLUSH device is superior in concept, operation and cost to other water-saving, retrofit devices for conventional toilets on the market. However, the initial material selection was inappropriate, and stronger materials must be chosen before the design is ready for manufacturing. Most importantly, time is of the essence due to the growing awareness of the problem and the almost certain development of competitive devices. This is a newly emerging market which is being driven by regulatory reform geared to reducing water consumption, improving water quality and lowering costs. This market is also being supported by an increasingly environmentally conscious consumer.

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE OF PROJECT

The purpose of this project was to develop a retrofit water-saving device for toilets that would give the user the option of flushing in the conventional, or a water-conserving mode. Convenience and affordability were cited as governing design criteria.

The project focused on a retrofit device that would accommodate the two major flushing valves (Crane and American Standard). The device was intended to replace the chain which commonly connects the flushing lever to the flushing valve. Ideally, the device would have no moving parts.

1.2 INCREASING INTEREST AND ACCEPTANCE OF RETROFITS

The importance of finding effective water conservation strategies is increasing, given the scarcity and rising cost of water as well as environmental concerns in many areas of North America, including Alberta. Those areas which have ample supplies are becoming increasingly aware that they can no longer afford to pollute this natural resource at the same rate as has been done in the past. The pressures of population growth, the increasing cost of fresh water, the equally increasing cost of sewage treatment and the need for improved resource management are spurring many municipalities and individual householders to investigate new methods to reduce water use.

Because toilets account for the largest percentage of indoor water use in the home, the demand for a convenient, affordable retrofit device is expected to increase as well. Fig.1 gives a typical breakdown of indoor water use in North America. Conventional toilets waste large amounts of water because they use the same volume to remove both solid and liquid waste. Although the average toilet uses about 22 litres of water per use, only 18 litres is actually required to remove solid wastes and 10 litres to remove liquid waste.

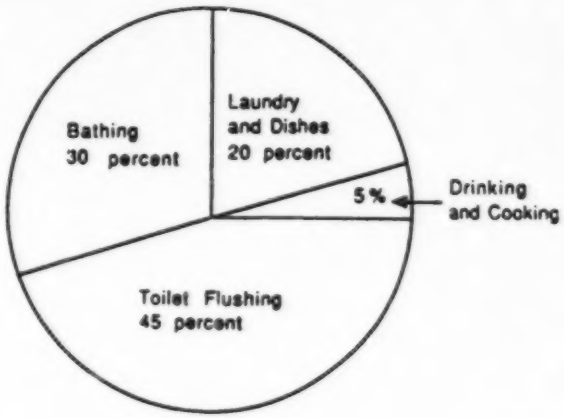


Figure 1. Typical breakdown of indoor water use.[4]

Given that the average person uses a toilet six times a day, it is reasonable to suggest that drastic water reduction could be achieved by using reduced-volume flushing devices. The City of Edmonton's Environmental Services, for example, estimates the average Edmontonian's water consumption at 260 litres per day. Of this amount, roughly 45% is used for toilet flushing, at a 1989 rate of nearly 5 cents per use, including sewage treatment.

Several recent initiatives suggest that the potential market size for retrofit toilet devices is growing in both Canada and the United States. In 1990, for example, the City of Edmonton hired a full-time employee to evaluate the feasibility of distributing water-reducing kits for showerheads and toilets. The City of Waterloo, Ontario, recently distributed 40,000

conservation kits to its water customers; the kit included a water-saving device for toilets.

In the United States, concerns over water shortage have resulted in public pressure to pass legislation geared to adapting higher plumbing standards for new housing starts, and are also expected to create more demand for retrofit devices. Texas and Arizona now include reductions in municipal per capita water use as a primary objective in their water conservation policies. New Mexico requires the state engineer to consider water conservation when granting a municipal water right application (1). Several municipalities in the United States have already purchased various water-conserving retrofit devices. According to a Water Resources Specialist for the City of Phoenix, Arizona, future revenues from the sale of such devices are likely to be in the tens of millions of dollars.

Many municipalities embarking on water-conserving schemes report that these programs made good economic sense. One advantage is that savings realized from reduced waste treatment costs can be directed to better treatment of water supplies. The East Bay Municipal Utility District in Texas, for example, found that retrofitting buildings and residences with water-saving devices resulted in a benefit-to-cost ratio of 25:1. (2)

Public participation seems to be surprisingly high in those North American cities where good potable water is becoming scarce. During a 1983 campaign, (3) several New Mexico cities found that 43% of all devices freely distributed were ultimately installed, with an estimated annual saving of 630 million litres of water.

1.3 ALTERNATIVE CONSERVATION STRATEGIES

In recent years, ultra-low volume flush toilets which use less than six litres per use have enjoyed increasing popularity. A few North American cities have enacted legislation to implement this new technology in their conservation schemes. As of March, 1989, the Massachusetts State Plumbing Board requires that all new toilets use six litres or less per flush, while the City of Los Angeles restricts the flushing volume to less than six litres per use.(5)

However, according to a survey conducted by the National Association of Plumbing, Heating and Cooling Contractors, the track record of low-volume toilets is not good. Of 251 contractors polled, 64% experienced more problems with these toilets, such as more back-ups, stoppages and drainage problems, than with conventional toilets. The most common complaint concerned cleanliness: 45% said it took two or more flushes to clear the bowl after each use.(6)

While this finding is not universally accepted, low-volume toilets alone will only have a gradual impact on efforts to conserve water, because they are mandatory only for new construction in a few municipalities in North America. An approach that reduces water consumption in existing toilets would have far greater immediate impact.

A number of other solutions have been developed to conserve water in conventional toilets. One is to place water-filled bottles or bricks in the cistern. These "water dams" permanently reduce water volume for each use by about 4 litres, or 18%.(7) The user, however, no longer has the option of a conventional flushing mode.

Some reduced-volume devices exist, but none of them allow the option of a conventional flushing mode. As a result, people unfamiliar with their operation find these devices difficult to operate. Home-owners and owners of commercial property are thus less likely to install these devices, even though they wish to conserve water, because of the problems the devices create for visitors or new users.

1.4 DATA SOURCES, RESEARCH METHODS AND FUTURE DEVELOPMENT

A review of literature on retrofit devices was undertaken, and telephone interviews were conducted with authorities involved in municipal water conservation projects in Canada and the United States. Federal and provincial authorities were contacted to determine the requirements for obtaining necessary approvals to market a plastic retrofit device. Two marketing studies were also conducted. Sintra Group Inc. studied consumer response to the ADJUST-a-FLUSH concept. The Faculty of Business Administration at the University of Alberta, prepared a marketing plan for ADJUST-a-FLUSH, which involved a survey of competition and a study of market trends in both Canada and the United States. Once a feasible design was completed, the product was installed in four houses for a two-month trial period.

1.5 DOCUMENT ORGANIZATION

This report is organized to include a review of existing approaches to retrofit devices for toilets, the attributes necessary in a desirable design, and the development, operation and market potential of the ADJUST-a-FLUSH system.
Following is a brief description of each section:

Section 2-Literature review on toilet water conservation and a description of the three basic flusher valve

systems. This section also contains a review of the current methods used for retrofitting toilets for water conservation, as well as a listing of the desirable characteristics of a successful retrofit device.

Section 3- This section contains a description of the development of the ADJUST-a-FLUSH, to its final form and its modes of operation,and a review of the laboratory experiments and field/user tests. This section also provides highlights from a marketing study, and an economic analysis of the device.

Section 4-This sections contains the conclusions for this project and indications of future directions.

2.0 LITERATURE AND INDUSTRY REVIEW

2.1 LITERATURE REVIEW

A literature search was conducted through the Industrial Water Conservation Information Sharing Network, usually referred to as Incon.Net, in Phoenix, Arizona. The network has an impressive listing of titles and publications dealing with all aspects of water conservation. Its directory also lists existing or planned regulations in communities across North America, as well as specific conservation information needed by the various municipalities.

2.2 REVIEW OF FLUSHING SYSTEMS

At the time this project was being undertaken there were three flushing mechanisms on the North American market. These included the old-fashioned ball valve, the widely-used flapper valve, and the American Standard Approach (ASA) used exclusively by that firm. Since that time American Standard has discarded the ASA mechanism in favour of the more reliable flapper valve. Ensuing work focused on the flapper valve with the assumption that any innovation could be modified for ASA application. Given the subsequent elimination of the ASA mechanism, ADJUST-a-FLUSH will enjoy even wider application.

The flapper valve is used in about 70% of toilets, making it the most common type in North America, followed by the ASA The ball valve is now almost obsolete and cannot be purchased as a complete unit. However, replacement parts are readily available. Fortunately, toilets which are equipped with the ball valve may be readily converted to the flapper valve. Therefore,

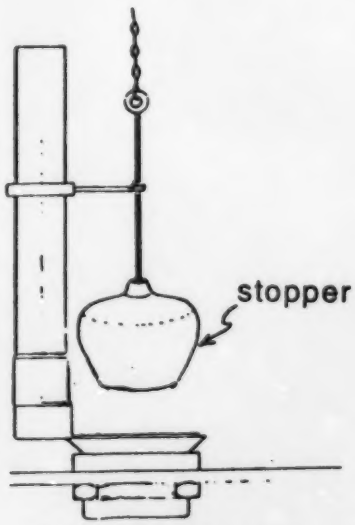
any new retrofit water conserving device needs only to work with the flapper valve and the ASA system.

Each of these systems has a built-in flotation chamber, and operates on the same principle. When the toilet is flushed, the valve is lifted from its seat. Buoyancy keeps the valve off its seat until the cistern is emptied.

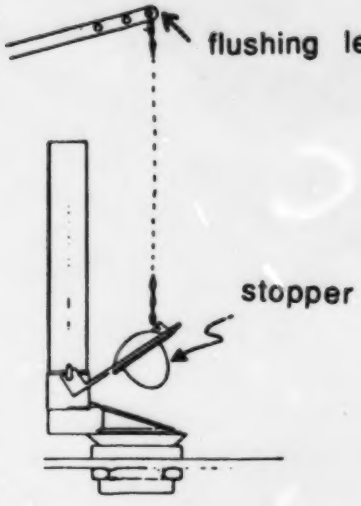
BALL VALVE

In the closed position the ball valve traps the water in the cistern. When the flushing lever is activated the ball valve is lifted from its seat, and water is allowed to flow out of the cistern.

Once lifted from its seat, the flotation chamber buoyancy will keep the valve from falling back until the cistern is emptied. Once the ball valve falls back on its seat the head of the rising water will create a downward pressure on the valve. This force is greater than the buoyancy of the ball valve, keeping it depressed in its seat. A drawback to this type of flusher is that the valve frequently sticks in the open position.



BALL VALVE (open)



FLAPPER VALVE (open)

FLAPPER VALVE

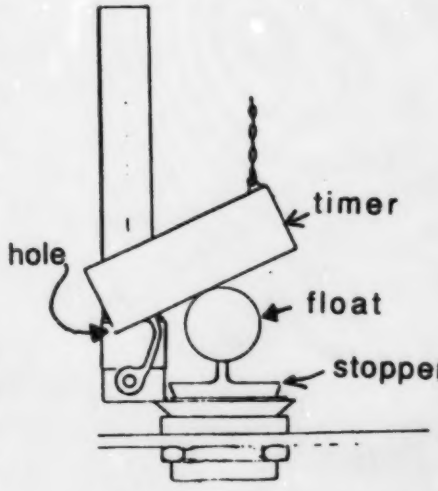
The flapper valve operates exactly as the ball valve, except that it is hinged. When at rest the float sits in the drain pipe below the water in the cistern, thus providing no buoyancy. The float only enters the water in the cistern when the toilet is in the flushing mode.

This hinged design is less troublesome than the sliding ball valve. Fortunately ball valve flushers are easily converted to the flapper valve.

AMERICAN STANDARD

This device consists of three major components: the shut-off valve, a float and a timer. The timer consists of a cup with a tiny hole in its bottom, which prevents premature closure of the valve before the cistern is completely emptied.

Once the valve is lifted, flotation chamber buoyancy will keep it from falling back on its seat. This is similar to the operation of the ball valve. However, once the water level drops below the float, the weight of this unit would close the valve before the tank was completely emptied if it were not for the counterbalancing weight of the water-filled timer about the pivot point.



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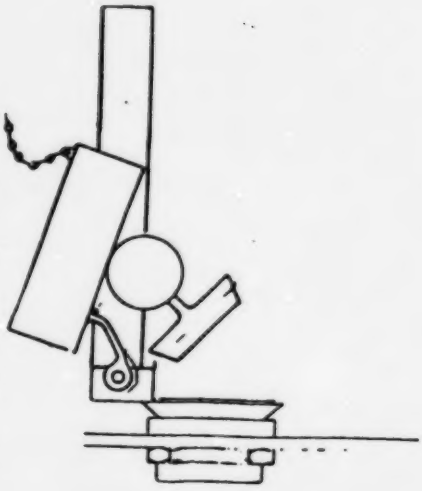


AMERICAN STANDARD (open)

To preclude the necessity of manually holding the valve handle in the flush position, the timer is designed to return the valve to the closed position once the cistern is empty. The timer, when immersed, is full of water. When flushed, the water level in the cistern drops, allowing the water in the timer to slowly drain through its hole. This timed release is sufficient to allow for the full release of the cistern; however, once the water drains from the timer, the valve outweighs it and falls into the closed position.

One drawback of this design is that, over time, the drain hole might become partially clogged, slowing or preventing the release of the water, thus keeping the valve open long after the cistern has drained. Since the water supply to the cistern is activated at all times except when the cistern is full, keeping the flushing valve open for longer than needed wastes water.

2.3 OPERATION OF WATER-SAVING RETROFIT DEVICES

Retrofit devices can reduce water consumption in toilets using any of three modes of operation:

1. REDUCED-VOLUME - The amount of water in the cistern is reduced by the introduction of bricks, water-filled bottles or similar "water dams".

2. VARIABLE - The user is able to terminate the flushing cycle any time after its initiation.

3. DUAL VOLUME - The user may choose between a regular flush and a reduced-volume flush.

Reduced-volume flushing is the simplest of the three modes. It provides savings of up to 20%.

Variable flushing can be achieved by either disabling the built-in floatation of the flushing valve, or by adding a weight to the flushing valve. In both instances the flushing valve will fall back on its seat as soon as the flushing lever is released. This allows the user to stop the water flow at will.
Based upon calculations derived from laboratory tests, water savings of up to 45% may be achieved if the user manually releases the lever at the optimal time.

Dual-volume flushing allows for two volumes of flushing water. Å reduced volume occurs when the toilet is flushed in the conventional way. When a larger volume is required to dispose of solids, the flushing lever can either be lifted, or held depressed, to release a larger volume of water. Some new toilets have two separate flushing levers--one for each type of flush. Based on laboratory tests, savings of up to 40% can be achieved through this method.

2.4 OTHER RETROFIT DEVICES ON THE MARKET

A large number of patents have been granted for dual-volume flushers. In some versions the user depresses the flushing lever for a reduced-volume flush, and lifts the flushing lever for a full flush. However, all of these, except one, are complicated devices with many moving parts and cumbersome linkage mechanisms that are prone to breakdown.

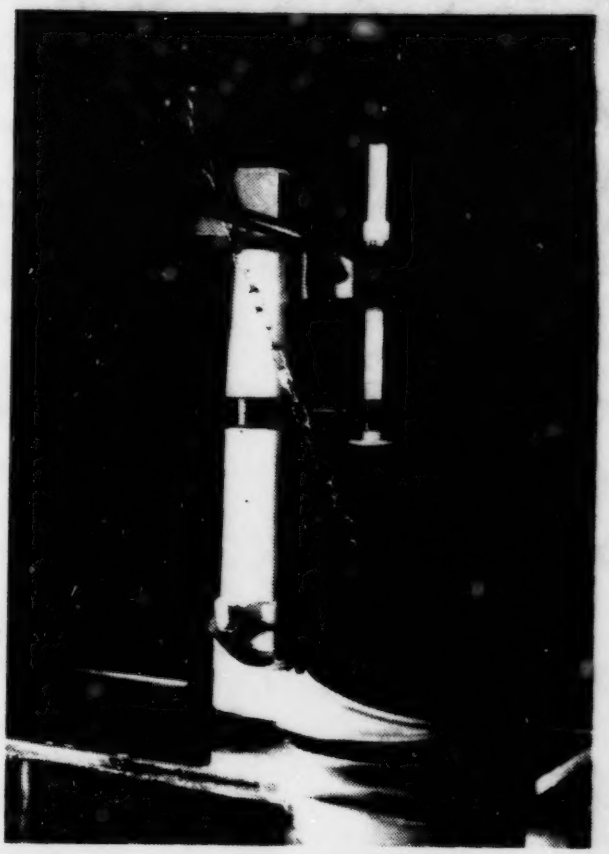
At least four water-saving devices are now on the market. They are the FuturFlush, the Select-A-Flush, the Aqua Saver, and the generic "water dam".
All of these devices, except water dams, replace the conventional operation of the flushing lever by providing a pre-selected amount of water for the reduced volume flush.Water dams, (bricks or water bottles) placed in the cistern effectively reduce the amount of water available for each flush.

The FuturFlush uses a split handle: one for a full flush, the other for a half flush. It retails for $15.

The Select-A-Flush gives a half flush when the lever is depressed, and a full flush when the lever is lifted.
It retails for $25.

The Aqua Saver provides a half flush when the lever is momentarily depressed, and a full flush when the lever is kept depressed during the flushing cycle. It retails for $9. It comes in two versions: one for flapper valves (Crane), and another one for American Standard systems. It provides a reduced-volume flush with each operation; for additional flushing action the user must keep the lever depressed.

As noted the Aqua Saver can be used on both of the predominant valve systems. The following description explains its use on the flapper valve.



OPERATION

- The device clamps onto the overflow pipe.
- A rod (Q) slides vertically through a groove on Clamp (F).
- A float (P) can be fixed at different points on the rod.
- When the cistern is filled with water the float will be immersed, rises and keeps the rod away from the flapper valve

When the toilet is flushed the water level drops below the float, causing it to lose its buoyancy. The full weight of the rod then presses down on the flapper valve closing it even if the flapper valve is still immersed in water. The position of the float on the rod determines the water level in the cistern at which the Aqua Saver prematurely closes the flapper valve.

By properly adjusting the float level on the Aqua Saver, the toilet will provide the proper reduced-volume flush with each operation. The purchaser must experiment with float level to determine the volume of water that will be consistently sufficient for a reduced-volume flush. The system's advantages are its cost, ease of installation and simple design for trouble-free operation. Its disadvantage becomes evident when one tries to adjust the float level once the device has been installed. Since it is difficult to make these adjustments "by feel", one has to remove the device from the toilet for each adjustment of the reduced-volume flush.

2.5 PERFORMANCE REQUIREMENTS FOR A SUCCESSFUL RETROFIT

Based upon the literature review and an analysis of available models, it became evident that to be successful, a water conservation device would have to exhibit the following:

1) Dependability:
   Consumers have become accustomed to relatively trouble-free toilet operation

2) Affordability:
   The item should retail for less than $10

3) Adjustability:
   The owner should be ableto make adjustments to the device without having to remove it from the cistern.

4) Ease of Operation:
   The device should retain the original flushing action to accommodate visitors and guests.

5) Range of Options:
   The device should provide the option of either dual-volume flushing or variable flushing, to satisfy a wide range of user preferences

6) Water savings:
   The device should provide a drastic increase in water savings compared with water dams

Whereas no current products meet these criteria, it was concluded that there was a need for a simple, easily-installed and adjusted retrofit flusher that would provide the user with both a dual flush capability, and a way to vary the water volume with each use.

3.0 THE ADJUST-a-FLUSH

3.1 EARLY EFFORTS

Because of similarities in operational concept, it appeared that a retrofit device for the flapper valve system could ultimately be modified to fit the American Standard flusher. Efforts were focused on designing a retrofit device solely for the flapper valve system.

To ensure that the performance and volume requirements of a new valve controller would not be affected by the variety of toilet bowls on the market, about 30 tests were conducted using colored water, in existing toilets which utilized the three previously-mentioned designs. The minimum amount of water needed to remove colored water from the bowl.was determined by gradually reducing water volume The tests were repeated three times to confirm the findings.
In all three cases, a 10-litre flush was found to be ample for clearing the bowl of colored water.

The initial effort focused on a retrofit device that provided a full flush when the flushing lever was depressed, and a partial flush when the handle was lifted. The approach involved working with the Aqua Saver device to devise an attachment that would disable the Aqua Saver when the flushing lever was depressed. (See Photo)

This model was then refined by an industrial designer who replaced the slider in the working model with a hinge, thus greatly simplifying the design while reducing the number of parts required. A prototype worked well in a mock-up tank, but the design was not suitable for mass production.

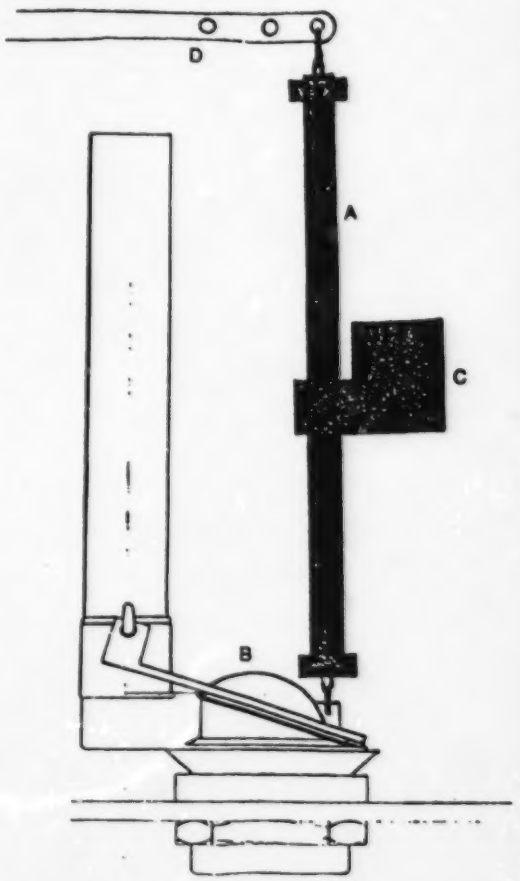
It was also subsequently felt that the the hinge might become a potential troublespot. The device also disabled the conventional flushing action of the toilet, that is, once the device was installed the toilet could not be flushed in the conventional mode. This defeated the goal of retaining the conventional flushing mode for the uninitiated user of the toilet.

Considerable time was spent fine-tuning the flusher but, unable to achieve the desired improvements, the design was eventually abandoned.

3.2 BASIC SOLUTIONS

A major breakthrough occurred when, instead of mounting the retrofit device on the toilet's overflow tube, efforts focused on installing a device between the flushing lever and the flapper valve. Integrating the chain in the tank with the retrofit device, produced a retrofit device without moving parts, save those already well tested in the existing valve operation.

The aim was to create a device consisting of a plastic tube (A) that mounts between the flushing rod (D) and the flapper valve (B). The tube slides over the chain and is locked into place with two snaps.
A detachable float (C), which creates neutral buoyancy in the assembly, can be attached anywhere along the length of the tube (A).



The device operates as both a dual volume flusher and a variable volume flusher:

DUAL VOLUME MODE:
When the toilet is flushed, both the flapper valve and the attached ADJUST-a-FLUSH become buoyant. As soon as the water level in the cistern drops below the bottom of the float, the ADJUST-a-FLUSH assembly loses its buoyancy, and its full weight presses down on the flapper valve, thus closing it prematurely.

To obtain a full flush the user keeps the flushing lever depressed.

VARIABLE VOLUME MODE:
To convert the ADJUST-a-FLUSH to a variable-volume flusher, the detachable float is removed. When the toilet is flushed, it will provide a conventional flush since the plastic tube itself is too light to prematurely close the flapper valve.

To shut off the toilet flushing cycle, the user simply lifts the flushing lever. This exerts a downward force on the flapper valve, and the valve shuts off the flow.

The device appeared simple to use and met the objectives of providing both a dual-volume flush and a conventional flush. But the first working model was too heavy, and closed the flapper valve as soon as the flushing lever was released. This was overcome by attaching some styrofoam material to the device to increase its buoyancy

3.3 PLANNING AND PROTOTYPE DESIGN

To facilitate rapid testing of prototypes, a limited volume mock-up toilet tank was constructed from plexiglass. It had all the required features of a conventional tank and provided the same head of water as a standard toilet but contained only 12 litres of water. This drastically reduced the time of each flushing cycle. The mock-up drained into a pail and, after test flushing, the pail was emptied into the tank and the procedure repeated. The see-through feature of the tank also helped immensely in assessing the performance of each design.

Once effort was focused on the chain-mounted ADJUST-a-FLUSH at least 100 separate tests were conducted in the mock-up tank to confirm the soundness of the design, before installing a unit in a standard toilet.

Once the preliminary design of the ADJUST-a-FLUSH had been resolved, contact was made with various government and private agencies which would be involved in the ultimate certification of a toilet retrofit device for Canada, to ascertain their views, comments and requirements.

Based on a review of the pertinent standards CAN/CSA-B125-M89, and CAN/CSA-B45, the standards for plumbing products and materials, and the standards for plumbing fixtures, respectively, and discussion with CSA staff, it was determined that the ADJUST-a-FLUSH will only have to meet one set of criteria:

The type of plastic used in the manufacturing of the retrofit device must be either:

a- "ABS plastic, to conform with Classification 3-2-2, or 5-2-2 as specified in ASTM Standard D1788,

b- "PP (Polypropylene) material, to conform with either Classification I-09208 or II-06407 as specified in ASTM Standard D4104", or

c- "PVC or CPVC material to conform with Classification 12454-B, 12454-C or 14333-D material as specified in ASTM Standard D1784."

As long as the toilet installation meets the plumbing code, the Plumbing and Gas Safety Services Branch of Alberta Labor is not concerned about CSA certification; however, the branch strongly leans towards CSA approval. It is aware of a number of off-shore toilet designs on the Alberta market which do not meet all CSA standards.

3.4 FIELD TESTS

Following laboratory development, the author operated two units in his house in order to solicit feedback from family members and visitors, which was used to fine-tune the design. Based on those findings, the industrial designer produced prototypes for field-testing by four Edmonton families over a two-month period. The families consisted of one couple, and three families with two teen-aged children; three children under twelve, and one teenager.respectively. Three of the families lived in single family dwellings in Edmonton; the fourth family were acreage dwellers.

The families were given an ADJUST-a-FLUSH along with a set of installation instructions. (See Appendix A) They were asked to install the device themselves, then to evaluate the dual-flush mode. After using this option for one month they were contacted and asked to install and use the variable flush option for a further month's tests at which time they were interviewed and their comments noted.

Specifically, the families were asked:

1) Whether help was needed to install the device
2) Whether help was needed to adjust the device
3) Whether they would purchase the $10 unit after trying it out
4) Which mode they preferred, dual volume or variable flush
5) Whether they were aware of any similar retrofit services on the market
6) Whether they knew the cost of flushing a toilet in Edmonton

The results were encouraging. None of the four families experienced any installation difficulties, and the device worked as anticipated. Only one of the four families quit using

the ADJUST-a-FLUSH after a few weeks, claiming "it was too much of a bother keeping an eye on the toilet bowl during each flush." (The device was in the dual-volume mode.)

Adjusting the device was no problem for two of the families; the other two required telephone instructions to complete the task.

Three of the four families preferred the dual volume flush to the variable flush.

The families were not aware of any similar retrofit devices on the market, and were also unaware of the cost of flushing a toilet in Edmonton.

The reactions were mixed. Following are some of the comments:
"Does it really cost five cents to flush my toilet?"

"It's hard to believe that a toilet uses 22 litres per flush"

"The thing is going to save me a bundle. You know what it costs me to truck water to my acreage?"

"I had no problem installing the thing, but I prefer the regular toilet flush." (It was felt that the add-on device might be a potential problem spot)

"I prefer using bottles of water in the tank. Costs nothing."

"I didn't believe I was using less water until I kept the cover off the tank and observed what was going on after I pressed the handle"

Two of the families said they would purchase the unit, and one family said it might. Only one family said it would not purchase it. (They preferred using water bottles in the tank).

The units worked well during the two-month field tests in four Edmonton residences, allowing the collection of feedback from the four families. But, eventually, all the units developed cracks in the undersized operating tubes, and they became inoperable. Overall, the field tests were considered successful in that they confirmed the feasibility of the device while, at the same time, providing some initial consumer feedback on the market potential of the ADJUST-a-FLUSH.

To better understand the flusher's potential, the project proceeded with a marketing survey for the ADJUST-a-FLUSH.

3.5 CONSUMER INTEREST IN ADJUST-a-FLUSH

A market study was conducted by Sintra Market Group to determine the marketability of a new type of toilet flusher system. Two approaches were used: 1) telephone interviews with consumers, apartment managers or owners, and motel and hotel managers, and 2) telephone interviews with prototype users.

Telephone interviews were conducted with 141 randomly selected consumers from the Edmonton telephone directory. Nearly two-thirds (63%) of the respondents were homeowners, and about one-third (37% were renters). Nearly equal proportions of respondents fell into each age category which were: 18 to 34 years; 35 to 54 years, and over 55 years of age. Slightly more women than men (60% versus 40%) were interviewed. One-third of the respondents had annual household incomes of between $20,000 and $40,000 per year and nearly one-third had incomes over $40,000. Seventeen per cent fell

below $20,000 and about one in five preferred not to answer this question. Five apartments, two motels and three hotels were also randomly selected. The interviewer first gave a brief introduction and then asked a number of questions to determine consumer interest in the product. (See Appendix A)

A vast majority of respondents (91%) thought the product concept was a good idea. Of the five percent who indicated it was not, responses ranged from "needing all the water for flushing, not in a buying position, current system is good" to "poor cost savings."

When asked if they would buy the product if it were reasonably priced, 24% said they definitely would, and 25% said they "probably" would. Of the "definitely buy" group, approximately half would buy the product for one toilet and half for two toilets. According to Sintra Group Inc., as a rule of thumb, a product should receive a 20 to 25% "definitely buy" score at the product concept stage.

Sixteen percent of the sample said they would "probably not" buy the product, and 11 percent said they would "definitely not" buy the product. The major reasons included not paying for water because they are renting, or because they have a well (acreage). Six people felt the product was not economical for their household and two felt the cost savings were poor.

When questioned about cost, 65% felt a price of $9.95 would be "very good value." Nearly 32% felt it was an "average value" and only three percent thought it was a "poor value."

A person's intention to buy, or perception of the product's value, did not seem to vary according to type of ownership (i.e. acreage, home owner or renter), age, income or sex.

Out of five apartment managers interviewed, two were enthusiastic about the product and one was unsure. Of the two who did not consider it a good idea for their buildings, one felt it would cost too much for the entire building, while the tenants pay for water and sewage in the other building. In other words, where apartment managers are responsible for water and sewage charges, one half thought ADJUST-a-FLUSH was a good idea.

All three hotel owners thought the toilet flusher was a good idea. One said he would definitely buy the product, the two others said they probably would. Both motel owners interviewed also though the product was a good idea.

The ADJUST-a-FLUSH Survey, completed in 1989, concluded that 28% of homeowners, renters and acreage owners in Metropolitan Edmonton would be interested in buying this product. It estimated a potential market size of about 79,000 households that would purchase at least one toilet flusher. According to Statistics Canada's 1986 census there were 836 000 households province-wide.

If the 28% figure is projected to municipalities in the province of Alberta, there would be a potential market size of at least 234,000 private households, based on a conservative estimate of more than 60% of Albertan households having more than one toilet. However, caution was urged because cities such as Calgary buy water, not individuals. At the same time, this fact may work in favor of marketing the product, because cities such as Calgary might be interested in bulk purchases of the product for distribution to households.

3.6 MARKETING PLAN FOR THE ADJUST-a-FLUSH

The U of A Business Faculty, through its Management Advisory Institute, each year selects a number of projects submitted by Alberta inventors for assignment to graduate students in the MBA program.

An application for assistance under this program, in developing a business plan for this project, including a marketing strategy and an analysis of the production, financing, management strategy and financial risks, was accepted.

The resulting 40-page *Marketing Plan for the ADJUST-a-FLUSH* concluded that the ADJUST-a-FLUSH is "one of the better water conservation devices yet invented, due to its ease of installation, dependable operation, low cost and quick payback of less than three months."

But it sounds a warning: "...[a] problem is the the ADJUST-a-FLUSH has only been tested to a limited extent, and will require not only further testing, but, (it would be a good idea to also obtain) CSA and Underwriters Laboratory approvals in Canada and the U.S. respectively" to assist in marketing the product.

"Another critical risk is, that the ADJUST-a-FLUSH may not be viewed as a superior product by consumers." This is a very valid point. The problem is that any retrofit water-saving device is immediately compared to "bricks in the tank". By placing bricks, water bottles or other water-displacing devices in the cistern the customer "knows" the difference his efforts will make. With the ADJUST-a-FLUSH or any other similar device the customer has to actually observe the water level in the cistern during the flushing action to notice the premature stoppage of the water flow. It is the amount of

water remaing in the cistern after the flush that reflects the saving. Fortunately this can be demonstrated at the installation when the user "tests" the system and leaves the top off the tank. What he then sees is actual water in the tank, not an empty tank with a botlle or brick in it. Furthermore, clear plastic tanks can be very effective point-of-purchase displays.

The analysis found three basic categories of customers for the product: industrial buyers, plumbers and real estate owners. Needless to say that in those communities with flat-rate water service, such as the city of Calgary, there is no incentive for consumers to purchase the ADJUST-a-FLUSH; however in these jurisdictions, the water authorities may be disposed to purchasing these units as they are the ones who will benefit directly from any savings in water consumption.

"Compared to the US and other parts of the world, there are relatively few areas in Canada which are in a water shortage situation. However, there are already some Canadian municipalities which are making efforts to reduce water consumption by their customers. By directly approaching municipalities which have a high water cost, the costs of a distributor and a retailer could be eliminated and the price of the ADJUST-a-FLUSH sold directly to municipalities could be markedly less than the anticipated retail price of around $10."

The report continues:
"The sheer number of retailers in Canada and the U.S means that it must be sold to them via a distributor. The potential sales volume for the ADJUST-a-FLUSH is quite large, given the appropriate promotion and support by the distributor. It is, however, possible that the sales to municipalities could limit sales by retailers."
In and around those jurisdictions where municipalities hand out free units, it is also reasonable to expect the retail potential of the ADJUST-a-FLUSH to be enhanced by the

massive free publicity, such a program would generate. In either case, the distribution of this product is enhanced."

The report suggests a few general requirements for successfully marketing the ADJUST-a-FLUSH through a distributor:
"There are several things that a manufacturer must do to get a distributor to market the product:

First, it must provide a reliable supply.
Based on information provided by an Industrial designer at the University of Alberta, the ADJUST-a-FLUSH could be produced in Edmonton in quantities exceeding 20,000 per day using only one injection molding machine, and do so at a production cost which would permit a retail price of about $10. This was confirmed by a plastics manufacturing company in Edmonton.

Second, the product must meet all state and federal regulations, i.e approved by the U.S Federal Underwriters Laboratory if one wishes to enter the American market. Based on the preliminary discussions with CSA it is felt that such approvals will be readily attainable.

Third, the product must be insured by the manufacturer against any liability that may result from its malfunction or installation." This is a normal business requirement which should not represent an impediment to the product's eventual production.

3.7 ECONOMIC ANALYSIS

Focusing on just one typical North-American municipalty, the City of Edmonton's Environmental Services estimates the average Edmontonian's water consumption at 260 litres per day. Of this amount roughly 45% or nearly 120 litres, are used for toilet flushing. As of September 1, 1989 the city of Edmonton's charge of $2.08 per 1000 litres of water, including sewage treatment, translates into nearly 5 cents per toilet use.

Individual Edmontonians could achieve the following economic benefits by reducing water consumption for toilet flushing as follows:

Dual-volume flushing__ savings of 40% or 48 litres per day.

Variable flushing_____ savings of 45% or 54 litres per day.

Based on the above, in the city of Edmonton, the individual could reduce his monthly water bill with dual-volume flushing and variable flushing by $3.00 and $3.40 respectively per person per month.

For a family of four, installing these units in both of the bathrooms found in the average home, this means a payback period of as little as two months if the ADJUST-a-FLUSH were marketed for under $10.

3.8 COMPETITION

Research indicates there is no competitive retrofit device on the market, that converts the flushing mechanism to a water saver while, at the same time, retaining the conventional flushing mode. Consequently, as noted in the marketing plan, ADJUST-a-FLUSH should enjoy an initial market dominance.

4.0 CONCLUSIONS AND FUTURE DIRECTIONS

The ADJUST-a-FLUSH is a viable retrofit water-saving toilet flusher. All currently available competitive systems provide the user with only the dual-flush operation. Since the ADJUST-a-FLUSH provides both a dual flush and variable flush options, the customer has the opportunity to evaluate both features before making a final selection to suit personal preference. It would appear that option 2, the variable flush, will be the ultimate choice for those who take water conservation seriously. The device is easy to install, convenient to use, and well-priced.

Before the ADJUST-a-FLUSH can be put into production, lighter and more durable materials will have to be selected and tested. This is a relatively minor step. Mass-production of the device in Alberta is feasible.

It is recognized that adapting to the dual-volume and variable-volume flushing will require behavioural changes on the part of the user. However, in the face of rising concern about water conservation and other environmental issues, it is believed that consumers would be sufficiently motivated to make such a change. Part of this belief stems from the significant behavioural change in garbage disposal habits in the City of Edmonton. In less than one year, Edmontonians who never gave their home garbage a second thought and sent plastics, glass, grass clippings, newsprint, cardboard and cans to the dump changed these habits, and began to wash, separate and sort their garbage in the world's most successful recycling project of its kind. Edmonton's "Blue Box" program is successful because of the consumers' increased awareness of waste problems and the need to find viable alternatives.

Water in North America is, by and large, still cheap and readily available, and many users don't know how much water they consume and what it costs. There are indications that this situation is beginning to change, and that rising costs and increased public concern about water conservation will make retrofit devices such as the ADJUST-a-FLUSH increasingly attractive.

THE ADJUST-a-FLUSH IS A PROVEN DESIGN THAT COULD BE MASS-PRODUCED AND MARKETED WITH A RETAIL COST OF UNDER $10

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APPENDIX "A"

Toilet Flusher Telephone Survey

Mr./Mrs. _____? My name is _____. I'm not selling anything. I'm conducting a survey for Sintra Market Research about a new product idea. We're trying to find out what people think about a new toilet flushing system. I'd appreciate a few minutes of your time to answer a few short questions. Your responses will be anonymous.

The product we're researching replaces the normal toilet lever system with a split lever that allows for full tank or half tank flushes. A standard toilet holds **5 gallons or 22 litres** of water. In Edmonton, each person uses an average of **100 litres of water per day** for toilets. If this amount was cut to **50 litres** by using one full flush and the rest at half flushes, you'd save at least **10 cents per person per day** on water and sewage. A family of four could regain the cost of the product in **less than one month.**

Q1. Do you think this product is a **good idea**?

☐ Yes ☐ No (why?_____) ☐ Unsure

Q2. If the product was priced **at $9.95** would you **buy it**?

☐ Yes/likely (for how many toilets in your home? _____)
☐ Maybe
☐ No (why? _____)
☐ Unsure

In order to help us **classify your responses**, please answer the following three questions.

Q4. Are you: ☐ an acreage owner ☐ homeowner, or ☐ renter?

Q5. In what **age category** are you?

☐ 18 - 34 ☐ 35 - 54 ☐ 55 or over

Q6. In which group does your annual **household income** belong?

☐ Less than $20,000 ☐ $20,000 - $40,000 ☐ Over $40,000
(☐ Prefer not to answer)

Q7. (Is the respondent: ☐ male ☐ female).

THANK YOU VERY MUCH FOR YOUR HELP.